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*[Remarks as prepared for delivery.]*

Good morning. Thank you for the introduction.

Last month, the Joint Planning and Development Office (JPDO) published a UAS Research, Development and Demonstration Roadmap that examines many aspects of the government's investment portfolio. Today is the first time we have shared our perspectives on the Roadmap with a broader audience. It is fitting that we are unveiling the Roadmap at a forum in Ohio because the Air Force Research Lab at Wright-Patterson provided significant leadership and technical expertise in developing the report content. Moreover, our first government workshop, where research-performers identified categories of UAS R&D challenges, occurred right here in Dayton in October 2010.

Let's start with "NextGen: The Short Story." The NextGen initiative seeks to transform the US air transportation system. NextGen is not a single piece of equipment or a program or a system that will instantaneously change aviation. NextGen must build on legacy air traffic control systems and avionics, taking advantage of technologies that have already been transforming our personal lives and the way we do business, such as GPS, analog-to-digital, and network-to-network data sharing.

Beginning in 2004, the JPDO created the NextGen vision by setting top-level goals for capacity, safety, environment, security, and international leadership. The JPDO engaged hundreds of technical experts from government, industry, and academia to plan NextGen research, describe it in a Concept of Operations, and add details within a database framework known as Enterprise Architecture.

Public law, the FAA's Modernization and Reform Act of 2012 (and its predecessor, Vision 100) calls for the JPDO to oversee NextGen R&D by coordinating goals, priorities, and research. It also requires that NextGen permit a wide range of aircraft operations.

In the 2005-2006 timeframe, when Very Light Jets (VLJ) were multiplying—as it was once said, threatening to blacken the skies—the JPDO did considerable analysis to see how these aircraft could be accommodated. The JPDO looked at what flight plans and airports might be used and what metrics were needed. Was the system flexible enough? Was it scalable to these new traffic patterns? Were new policies needed?

Fast forward to today. Last month a headline in PCWorld read, "TacoCopter Delivers Tacos by Quadrocopter." Is this a joke or a legit new San Francisco business? Okay, TacoCopter is not an actual service, but people are dreaming new ideas! Imagine: food delivery by flying robots!

This is a new frontier for aviation—uncharted territory. There are new flight paradigms for small, medium, and large UAS of varying performance. Pilot and controller roles for

this widely mixed fleet of remotely piloted and autonomous vehicles must be defined. Can UAS operate efficiently in the National Airspace System under the existing airspace policies?

NextGen must be scalable and flexible to account for the projected growth in UAS operations. While public agencies support the principles of "safety first," many are also very anxious to routinely operate UAS missions: hurricane tracking, military operations, border patrol, wildlife monitoring, and more. It sounds to me like a lot of different operations, with flight plans that don't look like direct city-pairs, and remote pilots who need certification. Indeed, forecasts project significant numbers of UAS operations.

The current National Airspace System was developed to accommodate the capabilities of manned aircraft. While many procedures and principles used for manned aircraft apply to UAS, there are significant differences in technological maturity, perception and acceptance, and operational experience that remain. NextGen must deal with these differences now so that the Air Traffic Management system has the technologies, policies, standards, and procedures it needs.

A few national development objectives for UAS integration were cited in the National Aeronautics Research and Development Plan published by the Executive Office of the President early in 2010 *(Ref. Executive Office of the President, Office of Science and Technology Policy, National Science and Technology Council, "National Aeronautics Research and Development Plan," Feb. 2010)*. The objectives were intended to address the demonstration of sense-and-avoid capability for UAS operating in airspace environments, ranging from low-density operations to high-density, metroplex or terminal operations. This Plan underscored the need for a coordinated multi-agency effort recognizing that "achieving safe UAS integration depends on a complex set of regulatory, technical, economic, and political factors that must be addressed in an integrated and systematic fashion."

Enter the JPDO. The JPDO provides a forum and collaborative environment for problem identification and resolution cutting across Federal agencies. The FAA has primary responsibilities as the regulator and airspace operator, but NextGen partners NASA and the Departments of Defense, Commerce, and Homeland Security each operate UAS in the airspace and some of these agencies conduct research.

Next, let's take a closer look at "What is (and is not) in the Roadmap." The UAS Research, Development and Demonstration Roadmap is the joint product of more than 60 experts from the JPDO and our NextGen partners. I found that the group engaged enthusiastically. The work was conducted using three in-person workshops between March and September 2011. Work was organized within four challenges which are common ways to think about this problem area: Communications, Airspace Operations, Unmanned Aircraft, and Human Systems Integration.

Our initial Roadmap document is a blueprint for identifying and addressing technical challenges. It establishes a set of research challenges for routine UAS operations in NextGen. It does not provide a complete timeline for UAS integration into the National Airspace System.

The Roadmap provides a baseline of the government-wide R&D goals for the current five-year planning horizon. Essentially, the Roadmap is a snapshot in time. The work also brought together researchers, regulators, and operators. It is not just another research plan. Rather, it led to an enduring approach to link the R&D activities of the partner agencies with the research needs of the FAA to support integration of UAS into the National Airspace System. The work also identified a series of next steps toward achieving a responsive, vetted roadmap and monitoring progress. As a result, we now have achieved a coordinated multi-agency effort.

Several major challenges stand out:

- Sense and Avoid capability for UAS
- Dedicated Protected Spectrum for control links
- Unmanned Aircraft and cockpit certification standards

Various parts of these challenges are specifically referenced in the report. The report is written, approved by all contributing agencies, and published. So what now?

The JPDO recommends three parallel phases of activity for UAS integration: accommodate, integrate, and evolve. Research is needed to support each of these phases. Today, operations are accommodated on a case-by-case basis. Will it be possible in the next few years for some UAS to take the off-ramp—to get to a more routine operation approach rather than management by exception?

In the mid-term, coincident with the FAA's current NextGen Implementation Plans (called Segments Alpha and Bravo), how will we define safe integration given the set of airspace technologies, procedures, and standards? For example, could operations take place in low-density airspace? Will the mixed fleet work in the same airspace?

Our UAS Roadmap work showed that a common concept of UAS operations for the mid-term is missing. In order to guide further research prioritization, we need a single point of view. From there, we can decide which research needs are most pressing.

As longer-term NextGen capabilities are deployed, UAS flights will benefit from the added capacity and increased flexibility through precision performance against agreed to and predictable flight paths. Automation will monitor aircraft performance against a known flight path and detect and resolve potential conflicts, freeing the human from some of these situations.

Many of the long-term research priorities for NextGen, including human systems integration, air/ground automation, software verification and validation, and cyber-security must be solved to enable safe and efficient UAS integration in the National Airspace System.

Quoting from the FAA's NextGen Web site, "It started with bonfires: immense torches waving from the horizons guided the first pilots from grass runway to grass runway as they delivered the most important commodity of the day: mail." The days of the barnstormers are long gone, with bonfires replaced by beacons and radar towers. With NextGen, satellites will guide manned and unmanned aircraft along their routes.

Knowing that even the technology path for UAS integration is not complete, the JPDO will bring our future-focus and collaborative methodologies together with our modeling

and simulation of alternative NextGen architectures to propose the means to identify and fill the R&D gaps. The UAS Research, Development and Demonstration Roadmap will serve as our launch pad.